

Achieving Sustainable Environment in Sub-Saharan African Countries: The Role of Remittances and the Moderating Influence of Financial Development

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Abstract

Driven by the role of remittances in sub-Saharan African (SSA) nations, this study scrutinizes the effect of remittances on environmental sustainability and the moderating role of financial development, using a robust measure of environmental quality. Using a sample of 27 SSA countries between 1991 and 2022, the study found the presence of cross-sectional dependency and slope heterogeneity. Based on these, the study utilized the second-generation estimation techniques. The empirical findings reveal that remittances, financial development, and economic growth accelerate environmental degradation, while urbanization reduces environmental damage in the long run. The result further shows that financial development moderates the adverse effect of remittances on the environment. Moreover, a

unidirectional causal relationship exists from remittances to the environment, and from financial development to the environment. Finally, policy prescriptions for environmental sustainability in SSA were offered based on the study's results.

Keywords: Remittance, Financial development, Ecological footprint, Environmental sustainability, sub-Saharan Africa

JEL: F24, G20, Q56

1 Introduction

Environmental sustainability and remittances among academics, developmental organizations, and policymakers have deepened recently. The attempt of economies worldwide to achieve economic advancement has resulted in increased energy and natural resource consumption, which affect the environment. Environmental degradation has intensified due to these circumstances, as dangerous and tainted pollutants are emitted into the

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environment regularly. Global Footprint Network (2023) estimates that over 80% of the world population lives in nations where resources are consumed more than the ecosystem replenishes them.

There are several channels through which REM can affect the environment. REM is anticipated to increase economic growth and reduce poverty through an increase in disposable income and provide additional sources of income for households, which will help to smoothen consumption, especially during the period of shock (Azizi, 2018; Konte, 2018). REM also serves as a source of finance to firms by providing the needed capital at zero cost, thereby increasing the investment based on the recipient country (Wagle, 2012) and source of foreign direct investment (Yoshino et al., 2020). Further, REM provides stable sources of foreign currency, which could be used to correct the balance of payment difficulties and developmental projects (Huay and Bani, 2018). Summing up the above discussion, REM increases economic and anthropogenic activities on the environment. The influence of REM on the environment rests mainly on how it is used. The environment benefits from REM if it is channeled toward clean and renewable energy and eco-friendly production and consumption; otherwise, the environment is worse off (Sharma et al., 2019). However, literature on the relationship between REM and the environment remains inconclusive (Dash et al., 2024; Shah et al., 2023; Elbatanony et al., 2021; Kibria, 2022; Usama et al., 2020; Yang et al., 2021; Neog and Yadava 2020; Khan et al. 2020; Sharma et al. 2019).

In spite of the limited studies that have examined the relationship between REM and

environmental degradation, there has been little research into how financial development (FD) impacts the relationship between REM and environmental degradation, especially in sub-Saharan Africa¹. A sophisticated financial sector can channel REM funds towards environmentally friendly technology, thereby improving the ecological asset (Sharma et al., 2019; Usama et al., 2020). When the recipient of REM inflow consumes energy-saving or efficient and environmentally-friendly equipment, environmental quality will be enhanced. Yet, FD can improve the inflow of REM and increase the consumers' demand for products, which boosts the production process (De and Ratha 2012). According to Irons and Irons (2019), the surge in production activities might increase energy utilization. The massive demand for energy usage could worsen environmental degradation (Yang et al. 2021). As a result of previous studies, this study claims that the magnitude of REM's environmental impact is contingent on FD. Thus, this study answers the following research question:

RQ1: How does FD moderate the relationship between REM and environmental sustainability in SSA?

This study used data from twenty-seven SSA countries from 1991 to 2022 to answer this question. The study makes four sets of contributions to the literature. First, this study is among the few that use ecological footprint (henceforth, EFP) as a proxy for environmental degradation to analyze the relationship between REM, FD, and environmental degradation in SSA. Previous studies in the environmental literature have included CO₂, sulfur, and methane emissions,

¹ The only known study that considered financial development as a moderator between remittances and environmental degradation is Arogundade, Hassan and Billa (2022). However, the study focused on Africa.

among others, which only measure a fraction of environmental degradation. Using EFP provides a comprehensive indicator and measures the entire anthropogenic activity in the ecosystem.

Furthermore, using EFP to measure environmental degradation is critical in SSA, where the primary sector accounts for most of the economy (UNCTAD, 1999). As a result, employing EFP allows us to capture different aspects of the ecosystem. Apart from this, FD is also proxy using newly developed IMF indicators. This measure yields a comprehensive index that captures banking and non-banking institutions' depth, access, and efficiency. Unlike the study of Arogundade et al. (2022), which focuses on 22 African countries and proxy FD with domestic credit to the private sector, this study extends the work of Arogundade et al. (2022) by focusing on 27 countries within the SSA and used a broad measure of FD which measure the three aspects of the financial sector.

Second, despite being one of the world's most REM-receiving regions, there are limited studies on REM, FD, and ecological degradation in SSA. SSA is an excellent place to examine this relationship. As Kadozi (2019) and Olayungbo and Quadri (2019) noted, REM has surpassed export income, FDI, and foreign aid as the most significant source of revenue for SSA in recent years. Besides, SSA is one of the fastest-growing regions with a high inflow of REM (World Bank, 2022). As a result, understanding the linkages between REM, FD, and the environment may aid policymakers in designing appropriate policies. Third, this study employs Augmented Mean Group (AMG) and Common Correlated Effect Mean Group (CCEMG) to address the issues of cross-sectional dependence between cross-sectional units and spatial

heterogeneity, which earlier studies failed to address. The analysis of panel data models with cross-sectionally dependent errors—also called unobserved common factors or multifactor error structures—has garnered more attention recently. This is due to empirical applications in economics, such as the global financial crisis and common shocks. The dependencies between the units violate the usual assumption of independent and identically distributed errors; typical panel estimation techniques (such as fixed effects estimation) may have detrimental impacts and result in inconsistent estimations and false conclusions. Predominant approaches for dealing with cross-sectionally dependent errors in panel models are AMG and CCEMG. The AMG approach allows for unbiased estimations in the presence of cross-section dependency or no cross-section dependency. The basic idea of the CCEMG method proposed by Pesaran (2006) is to proxy the unobserved common factors using the cross-sectional averages of the observables in the regression. Fourth, the outcome of this study shows that remittances, financial development, and economic growth accelerate environmental degradation while urbanization reduces environmental damage in the long run. The result further shows that financial development moderates the adverse effect of remittances on the environment. Finally, the study found a unidirectional causality from remittances and financial development to the environment. The subsequent sections of this study are as follows. Section 2 presents the literature review. Section 3 discusses the data, model, and methodological framework. Section 4 focuses on empirical research and discussion. Section 5 offers the conclusion, policy implications, limitations, and directions for the future.

2. Literature Review

2.1. Theoretical Proposition

According to the literature, there are five interaction mechanisms through which REM affects the environment. Figure 1 presents the graphical representation of the theoretical link between REM, FD, and environmental quality. The first stage is that REM increases households' income. Due to the problems of unemployment, lack of infrastructure, illiteracy, and low per capita income, many people migrate from developing countries to other countries where they can earn a higher income. Therefore, migrants tend to send some of their income to support their family members in their home countries after gaining employment. This, hence, increases the personal income of the receivers' households. De and Ratha (2012) assert that REM inflows increase household income and increase the demand for products that augment the production process. Similarly, Elbatanony et al. (2021) state that REM is one of the sources of household income and a major determinant of economic development in developing countries.

The second stage is that the rise in the income of the households upsurges their consumption and savings. The increase in the income of the households offers them the opportunity to increase their demands for both durable and non-durable goods to raise their standard of living and save for the future. People tend to save in developing countries due to fear of uncertainties. In stage three, there is a surge in aggregate demand and savings. By increasing consumption, aggregate demand increases, while savings increase bank deposits. As households increase their consumption of durable and non-durable goods, the pattern of aggregate demand is

altered. Likewise, the increase in savings automatically increases the bank deposits of the financial institutions, implying that any variation in savings causes drastic changes in bank deposits. Due to a rise in aggregate demand, industrial production increases in stage four. Bank deposits rise, improving the financial sector. Likewise, an increase in aggregate demand necessitates an increase in industrial production as industrial firms increase their production to meet the increase in aggregate demand. Firms and industrialists use increased deposits by borrowing short-term and long-term funds to expand production or start new firms. However, the ability of financial institutions to make funds available leads to their efficiency. Stage five relates that increased productivity and bank development leads to increased environmental degradation. Increasing productivity and FD are two primary sources of environmental degradation. To increase productivity, the industries use more energy (e.g., oil, natural gas, coal, etc.), increasing emissions.

2.2. Empirical Research

The literature review is offered in three groups. The first group consists of studies examining REM's effect on environmental degradation. The second group studies the relationship between FD and environmental degradation, while the last group focuses on studies examining the moderating impact of FD.

2.2.1. Remittances and environmental degradation

No consensus exists among the studies examining REM's influence on environmental degradation. Some studies found a positive impact of REM on environmental quality, while some found that REM worsens environmental quality. The studies that found a negative connection between REM and environmental

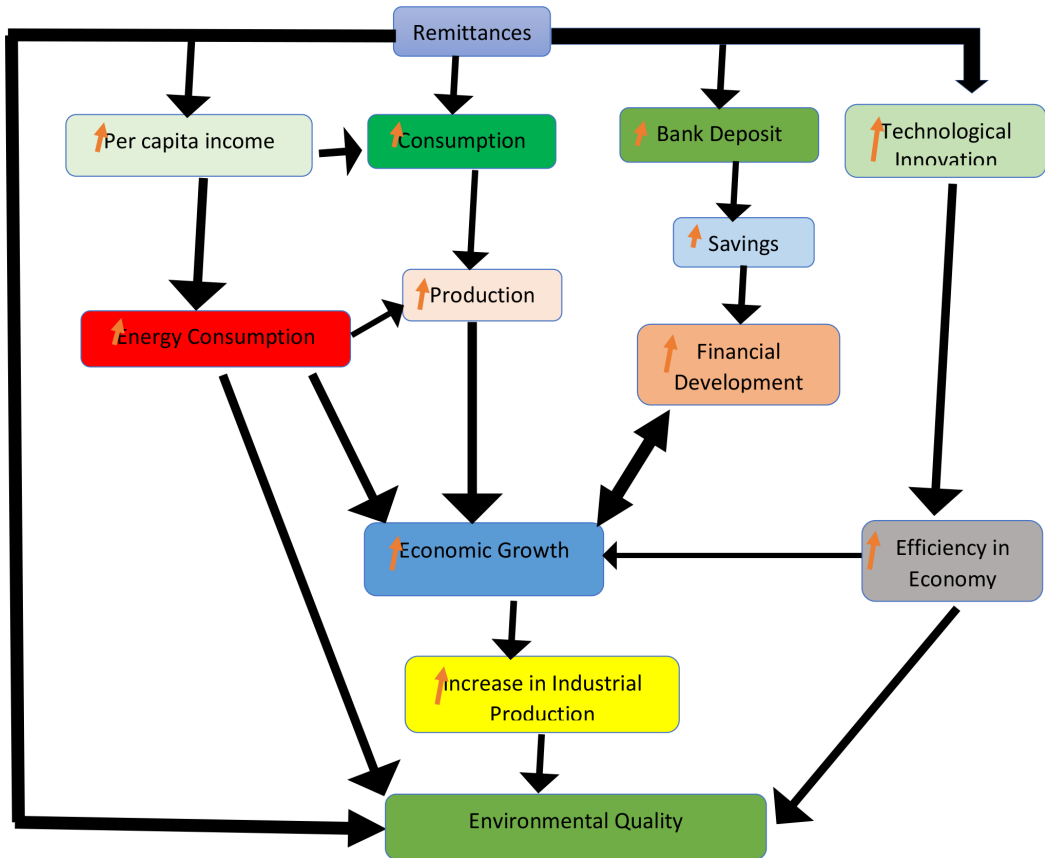


Figure 1. Theoretical Framework

Sources: Yang et al. (2021), Villanthenkodath et al. (2020), and Ahmad (2019)

quality are based on the argument that REM inflows increase household consumption of investment goods, and consumer durables increase CO₂ emissions. For instance, Ahmad et al. (2019), using NARDL, show that REM increases CO₂ emissions with evidence of asymmetry in the link in China from 1980 to 2014. The study found that positive shocks in remittances increase CO₂, while negative ones decrease CO₂. The findings by Kibria (2022) are consistent with Ahmad et al. (2019), as the study investigated the connection between remittances and CO₂ in Bangladesh using the NARDL model from 1980-2016. The study found that increasing remittances

worsens environmental degradation, while decreasing remittances reduces environmental degradation. In India, Neog and Yadava (2020) examined the connection between remittance and environmental sustainability during 1980–2014. The study found that a positive rise in REM triggers environmental deterioration, whereas adverse REM shock diminishes it. Akinlo (2022) employed NARDL to investigate the impact of the increase and decrease of remittances on environmental degradation in Nigeria. The study covered the period from 1980 to 2018. The study employed both CO₂ and ecological footprint to measure environmental degradation and found that positive shocks to remittances

promote environmental degradation in Nigeria. A study by Brown et al. (2020) differs slightly from earlier studies, as they employed both ARDL and NARDL approaches to investigate the symmetry and asymmetry relationship between CO₂ and REM in Jamaica. The study discovers that CO₂ and REM have a threshold relationship, with CO₂ reaching its maximum point when REM per capita hits \$450. Following that, CO₂ emissions decrease as REM rises. Aside from the time series studies, other studies employed panel data to investigate the connection between remittances and environmental degradation. For instance, Khan et al. (2020) used panel data to investigate the relationship between remittances and environmental degradation in the BRICS region during the period from 1986 to 2016. The study employed FMOLS estimates as the estimation technique and found that environmental degradation is worsened by the inflow of REM to Brazil, Russia, and China, but REM helps reduce environmental degradation in India. The study by Yang et al. (2021) also focused on the BRICS economies from 1990 to 2016. The study employed dynamic seemingly unrelated regression (DSUR) and FMOLS approaches to investigate the connection between remittances and environmental degradation in panel samples and individual nation analyses. The study found that REM inflows aggravate environmental deterioration in panel samples and individual nation analyses. However, within the asymmetric framework, Dash et al. (2024) conclude that positive shocks in REM degrade the environment, while negative shocks strengthen it in South Asian countries. Furthermore, within the asymmetric framework, Shah et al. (2023) also concluded that REM increases CO₂ emissions in G-11 countries.

As stated earlier, some studies have found that REM improves environmental quality.

Those studies are based on the argument that REM leads to producing environmentally friendly goods and enhancing environmental quality. Among those studies are López-Feldman and Chávez (2016), who examine the link between REM and natural resource extraction in Mexico. For the analysis, the researchers employed quasi-maximum likelihood estimation. The study's outcomes reveal that REM inflows influence households' utilization of natural resources. REM limits household involvement in natural resource exploitation. The study concluded that REM inflows relieve the demand for natural resources, resulting in minor environmental damage. Arogundade, Hassan and Bila (2022) investigated the relationship between remittances and environmental quality in 22 African nations. The study found that REM improves environmental quality in SSA. Sharma et al. (2019) explored the nexus between foreign aid, growth, REM, and carbon dioxide in Nepal, and they discovered that REM lessens CO₂ emissions. In Ethiopia, Usama et al. (2020) found that REM lessens CO₂ emissions. Zafar et al. (2021) shows that REM lowers CO₂ emissions and, as a result, reduces environmental damage. When investigating the connection between REM inflows and environmental performance, Wawrzyniak and Dory (2020) discovered that REM does not affect ecological quality. While extant studies on the linkages between REM and environmental quality are mixed, this study outlines the first hypothesis as follows:

H1: REM is significantly associated with environmental degradation

2.2.2. Financial Development and Environmental Degradation

The debate on the nexus between FD and ecological degradation is ongoing, as there is

no agreement in the literature on whether FD enhances or worsens environmental quality. According to Arogundade, Hassan, and Bila (2022), FD can positively or negatively affect environmental degradation as financial institutions increase the likelihood of a household's consumption of environmentally harmful goods and, in other words, increase the consumption of environmentally friendly goods. Some studies found positive effects of FD on environmental degradation. In 26 African countries, Adams and Klobodu (2018) investigated if a political regime is relevant in the relationship between FD and environmental degradation in a study comprising 26 African countries from 1985 to 2011. The study used the Chow test, cross-country regressions, and the GMM. After accounting for political regimes, the study found that FD positively affects environmental degradation. Likewise, Xu et al. (2018) show how FD is connected to environmental degradation using globalisation and electricity consumption in Saudi Arabia from 1971 to 2016. The study used ARDL and VECM as the estimation techniques and found that FD contributes to CO₂ emissions in Saudi Arabia. Ahmed et al. (2021) examined the role of economic globalisation, economic growth, and financial development on the ecological footprint in Japan. The study employed symmetric and asymmetric ARDL methods. The study found that FD is associated with increased environmental degradation in Japan. Other studies, such as Boutabba (2014), Taher (2020), and Dada et al. (2022c), established that FD contributes to environmental degradation.

In contrast to the studies that found that FD worsens environmental quality, some reported that FD benefits the environment. For instance, Al-Mulali et al. (2015) analyse the effect of FD on CO₂ emissions in 129 countries from

1980-2011. The study employed the dynamic ordinary least squares (OLS) and the Granger causality for the estimations of the results. The study found that FD boosts environmental quality in the short and long run. Similarly, Salahuddin et al. (2015) show a negative connection between FD and CO₂ emissions in the GCC countries while investigating the relationship between CO₂, economic growth, electricity consumption, and FD from 1980 to 2012. The study employed DOLS, FMOLS, and the dynamic fixed effect model (DFE) to estimate the data. Shahbaz et al. (2016) employ NARDL to scrutinise the relationship between FD and environmental degradation in Pakistan from 1985Q1 to 2014Q4. The study used the NARDL approach and found that FD enhances ecological quality. Saud et al. (2019) investigated if government expenditure and financial development impeded environmental degradation in Venezuela for the period from 1971 to 2013. Using ARDL, the study concludes that FD strengthens Venezuela's environmental quality. Summing up the above discussion, FD significantly impacts REM and environmental quality. Based on this, the study formulates hypothesis two as follows:

H2: FD has a significant influence on environmental degradation

2.2.3. Remittances, Financial Development and Environmental Degradation

Some studies have also documented that FD moderates the linkages among various macro and socioeconomic variables. For instance, in the top ten REM-receiving countries, Aljadani et al. (2023) examined the heterogeneous effects of the remittance and FD inflow on environmental pollution from 1980 to 2018. The study used a panel quantile regression technique and found that the interaction of

REM with FD on CO₂ is significantly negative across all quantiles. In a study comprising 22 African countries, Arogundade et al. (2022) examined the impact of diaspora income on environmental degradation for the period 1990-2017. The study employed techniques like the Driscoll-Kraay fixed-effect model, fixed-effect instrumental variable regression, panel quantile regression, and the Dumitrescu and Hurlin causality test to estimate the results. The study found that the interaction of FD and REM promoted environmental quality. However, other studies considered institutional quality and technology as mediating variables in the relationship between remittances and environmental degradation. For instance, Awad et al. (2024) investigated the joint effect of remittances and institutional quality on environmental quality in 44 economies in the SSA for the period 2000-2022. The study employed PMG-ARDL for the analysis. The study found that remittances had a negative long-term impact on environmental quality. Conversely, the study found that institutional quality positively affected the per capita ecological footprints. Finally, the results established that institutional quality over time mitigated the adverse impact of remittances on the environment in the sampled SSA countries.

Yadou, Ntang, and Baida (2023) investigated the effect of remittances on the ecological footprint in 30 African countries, taking information and communication technology as a mediating variable. The study covered the period from 2000 to 2021 and used Two-Stage Least Squares (2SLS) with instrumental variables and quantile regression. The result showed that ICTs minimise the adverse effect of remittances on environmental degradation. The study of Islam and Alhamad (2023) submits that FD mediates

the nexus between REM and growth in the topmost REM-receiving countries. Similarly, Barkat et al. (2024) established that financial inclusion mediates the nexus between REM and sustainable development goals in 109 developing countries between 2000 and 2022. Dada et al. (2024c) stressed that FD moderates the relationship between energy, poverty, and the sustainable environment in Africa. Hence, it would be reasonable to assume from the above literature that FD moderates the linkages between REM and environmental degradation in SSA.

H3: FD moderates the linkages between REM and environmental degradation

3. Research Design

3.1. Data and Sample

To investigate the effect of REM and financial development on the EFP, a balanced panel of data is sourced from 1991 to 2022 for twenty-seven sub-Saharan African countries (Appendix 1). Aggregate EFP is used to proxy environmental degradation and measure the ecological footprint per capita. REM are measured as a proportion of GDP, encompassing personal transfers and employee compensation. The FD index is obtained from the International Monetary Fund (IMF, 2019). This measure provides a comprehensive view of FD by measuring the financial depth, access, and efficiency. Compared to the study of Arogundade et al. (2022) that measures FD using financial depth, this measure of IMF offers an all-inclusive index that encapsulates the banking and non-banking institutions (Svirydzenka, 2016). Foreign direct investment (FDI) is calculated as the net inflow of FDI and as a proportion of GDP. Urbanization (URB) is measured as the number of urban populations to the total population. Data on EFP is sourced from the

Global Footprint Network, while data on REM, economic growth, urbanization, and trade openness are obtained from the World Bank Development Indicator (WDI).

The period for this study ranges from 1991 to 2022 based on the accessibility to data on essential variables that influence the environment. Table 1 presents a descriptive and pairwise correlation matrix for the series. The summary of the descriptive statistics suggests that the variables are normally distributed; thus, the measures of central tendency values are very close. Specifically, EFP has an average value of 1.44 global hectares per capita with a minimum of 0.653 and a maximum of 3.818; thus, EFP in Africa is positively skewed. REM values range between 0 and 145.149, suggesting that some countries in the region receive nothing as diaspora income. FD also varied, with a standard deviation of 0.146. The mean real GDP per capita (GDP) value is 1900.602, above the median (847.150). A positively skewed distribution of GDP per capita can be inferred from this. Apart from the descriptive statistics, the correlation matrix indicates the nonappearance of multicollinearity among the series.

3.2. Model Specification

This article investigates the direct effect of REM, FD, urbanization, economic growth, and trade on the environment and the indirect impact of FD in the linkages between REM and the environment in SSA. To achieve these objectives, the extant model in the environmental literature is adjusted to accommodate the variables mentioned earlier (Elbatanony et al., 2021; Yang et al., 2020; Arogundade et al., 2022). The baseline model for examining the direct effect of the variables on EFP is stated in Equation 1

$$EFP_{i,t} = \alpha + \beta GDP_{i,t} + \gamma REM_{i,t} + \eta FD_{i,t} + \delta FDI_{i,t} + \kappa URB_{i,t} + \varepsilon_{i,t} \quad (1)$$

where, $EFP_{i,t}$ stands for ecological footprint, which serves as a proxy for environmental degradation; GDP represents economic growth, REM is remittances, FD is financial development, FDI is foreign direct investment, URB is urbanization, i represents the country, and t is the period.

An interactive term of FD and REM is included in equation 1 to observe the indirect effect in the nexus between REM and the environment.

$$EFP_{i,t} = \alpha + \beta GDP_{i,t} + \gamma REM_{i,t} + \eta FD_{i,t} + \lambda (REM * FD)_{i,t} + \delta FDI_{i,t} + \kappa URB_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where $REM * FD$ is the interactive term.

From equation 2, the coefficient of the interactive term has some implications. A significant positive coefficient " λ " implies a complementarity between FD and REM in abating EFP. However, a significant negative coefficient hints at substitutability between FD and REM in reducing EFP. Further, an insignificant coefficient reveals that neither FD nor REM complement or substitute each other in affecting the environment. From equation 2, the net effect of FD, which is the moderating term in the linkages, can be obtained using the approach in the literature (Dada et al., 2024a; Tchamyou et al., 2019), and it is described in equation 3

$$\frac{\partial EFP_{it}}{\partial REM_{it}} = \beta + \lambda FD_{it} \quad (3)$$

The average value of FD in Table 1 is substituted into the model to obtain a scalar value for Equation 3. Furthermore, the values of the coefficients (β, λ) must be significant for the net effect to be obtained.

3.3. Methodological framework

3.3.1. Cross-sectional dependence test

One of the pertinent questions in panel data analysis is the issue of cross-sectional dependence (CD), which could lead to inefficient and inconsistent estimated coefficients if not given adequate attention in the model. Globalization has made countries a global village, where shocks in one country are easily transmitted to another country through the contagion effect (Akinlo and Dada, 2022; De Hoyos and Sarafidis, 2006). Hence, the postulation that no CD exists in African countries could be biased and lead to unreliable inferences. To test for the assumption of CD in the panel, Pesaran CD (P-CD), Breusch and Pagan LM (BP-LM), Bias-Corrected Scale LM (BCS-LM), and Pesaran Scaled LM (PS-LM) tests are deployed. These methods produce consistent and efficient output. The Pesaran (2004) CD is expressed as:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N \widehat{\rho}_{ij} \right) \sim N(0,1)_{i,j} \quad (4)$$

Where $\widehat{\rho}_{ij}$ is the residual pairwise correlation, N is panel size, and T is the time dimension. The null hypothesis of CD is stated as

$$H_0: \rho_{ij} = \text{corr}(\mu_{ij}, \mu_{jt}) = 0 \forall i \neq j \quad (5)$$

3.3.2. Slope Homogeneity Test

Pesaran and Yamagata's (2008) test statistic tests the slope homogeneity. This test statistic takes care of CD in the series. The Pesaran and Yamagata test model is stated as follows:

$$\tilde{\Delta} = (N)^{\frac{1}{2}} (2K)^{-\frac{1}{2}} \left(\frac{1}{N} \tilde{S} - k \right) \quad (6)$$

$$\tilde{\Delta}_{adj} = (N)^{\frac{1}{2}} \left(\frac{2k(T-k-1)}{T+1} \right)^{-\frac{1}{2}} \left(\frac{1}{N} \tilde{S} - k \right) \quad (7)$$

$\tilde{\Delta}$ is the delta tilde while $\tilde{\Delta}_{adj}$ is the modified delta tilde. Based on the null hypothesis of slope homogeneity across cross-sections, equations 6 and 7 are derived.

3.3.3. Unit root tests

Second-generation stationarity tests that account for the existence of CD in the panel data are used. Cross-Sectionally Augmented Dicky-Fuller (CADF) and Cross-Sectionally Augmented IPS (CIPS) tests are more reliable and produce consistent results. The model of CIPS is given as:

$$\Delta Y_{it} = \alpha_i + \alpha_i Y_{i,t-1} + \alpha_i \bar{Y}_{t-1} + \sum_{l=0}^p \alpha_{il} \Delta \bar{Y}_{t-1} + \sum_{l=0}^p \alpha_{il} \Delta Y_{i,t-1} + \mu_{it} \quad (8)$$

Where $\bar{Y}_{t-p}$ and ΔY_{t-j} is the lagged level mean and the first difference operator.

The statistical test of CIPS is expressed thus:

$$\widehat{CIPS} = N^{-1} \sum_{i=0}^n CADF_i \quad (9)$$

3.3.4. Cointegration Test

The long-run cointegration is established using Westerlund's (2007) test. Westerlund (2007) is preferred over other panel cointegration tests since it addresses CD and heterogeneity problems in panel data, thus producing robust and reliable results. Westerlund (2007) has four test statistics, namely:

$$G_{\tau} = \frac{1}{N} \sum_{i=1}^N \frac{\widehat{\beta}_i}{SE(\widehat{\beta}_i)} \quad (10)$$

$$G_{\alpha} = \frac{1}{N} \sum_{i=1}^N \frac{T \hat{\beta}_i}{\beta_i(1)} \quad (11)$$

$$P_{\tau} = \frac{\hat{\beta}_i}{SE(\hat{\beta}_i)} \quad (12)$$

$$P_{\alpha} = T \hat{\alpha} \quad (13)$$

Equations 10 and 11 are the group statistics, while equations 12 and 13 are the panel statistics. Westerlund's cointegration test requires at least one cross-section for the group test and all cross-sections for the panel test. From equation 13, the error correction term is obtained following the works of Ahmad et al. (2021) and Dada et al. (2022c), and it is expressed in equation 14:

$$\hat{\alpha} = \frac{P_{\alpha}}{T} \quad (14)$$

$\hat{\alpha}$ connotes error correction term.

3.3.5. Long-run regression estimate

The Augmented Mean Group (AMG) estimation technique examines the long-run relationship among the series. This study employed the AMG estimator because it can account for cross-sectional dependence by including a "common dynamic effect" in the country regression. Likewise, panel studies with a small N observed over extended periods (small T) are a good fit for AGM. Other names for this kind of panel data include "data fields," "panel time-series," and "macro panels" (Eberhardt, 2012). The majority of panel data econometric theory, according to Hernández (2015), is designed to analyse survey data, which often consists of a large number of cross sections (large N) seen over very short periods (small T). Nonetheless, cross-section dependence and parameter heterogeneity are presumed to exist in macro panels ($T > N$). In addition, the AMG also

accommodates nonstationary variables. The AMG technique follows two-stage methods, which are specified thus:

Stage 1

$$\Delta y_{it} = \alpha_i + \beta_i \Delta x_{it} + \tau_i f_i + \sum_{t=2}^T \delta_i \Delta D_i + \varepsilon_{it} \quad (15)$$

Stage 2

$$\widehat{\beta}_{AMG} = N^{-1} \sum_{i=1}^N \hat{\beta}_i \quad (16)$$

Δ is the difference sign, y, and x are the variables, β_i is the country-specific coefficient, f_i is the unobserved common factor with the heterogeneous factor and δ_i is the time.

Common Correlated Effect Mean Group (CCEMG) is employed to check the reliability of AMG. CCEMG considers the heterogeneous slope across individual cross-sections by taking the average of every particular country's elasticity. The common factors are treated as nuisance parameters in the CCEMG model. By adding the cross-sectional averages of the regressors and the dependent variable as extra regressors, this model resolves the problem of cross-section dependence. Pesaran (2006) demonstrated that these averages can explain the unobserved common factors. By estimating individual equations and then calculating the average of the factor loadings, the problem of the differentiated impact of common factors is resolved. One benefit of the CCEMG test is its capacity to rectify inaccuracies related to cross-sectional dependent data. Furthermore, by estimating the coefficients of interest independently, it employs mean group in a dynamic panel and can approximate cross-sectional dependence using lags and cross-section averages. The unweighted variance of the cross-sectional particular coefficients

is the asymptotic variance of the mean group coefficients. The CCEMG equation is expressed in equations 17 and 18.

$$\Delta y_{it} = \alpha_i + \beta_i x_{it} + \psi_i \bar{y}_{it} + \eta_i \bar{x}_{it} + \tau_i w_i + \varepsilon_{it} \quad (17)$$

$$CCEMG = N^{-1} \sum_{i=1}^N \hat{\eta}_i \quad (18)$$

3.3.6. Dumitrescu and Hurlin (D-H) Panel causality test

Dumitrescu and Hurlin's (2012) causality is used to examine the direction of causation between the variables in a heterogeneous setting. This approach has the following advantages over other conventional causality tests. One, it corrects for CD and heterogeneity in the panel; two, it gives reliable results even in small data properties ($T < N$); and three, the test can be applied to balanced and unbalanced panels. The D-H model is presented in a functional linear model thus:

$$x_{i,t} = \alpha_{1i} + \sum_{k=1}^K \alpha_{1i}^{(k)} x_{i,t-k} + \sum_{k=1}^K \beta_{1i}^{(k)} y_{i,t-k} + \mu_{1i,t} \quad (19)$$

$$y_{i,t} = \alpha_{2i} + \sum_{k=1}^K \alpha_{2i}^{(k)} y_{i,t-k} + \sum_{k=1}^K \beta_{2i}^{(k)} x_{i,t-k} + \mu_{2i,t} \quad (20)$$

x and y are stationary explained and explanatory variables.

4. Empirical Findings and Discussion

4.1. Econometric properties of the data

The study starts this process by exploring the likelihood of CD in the variables. The CD report is displayed in Table 2. A test is conducted to determine whether CD is present in the series compared to the null hypothesis of no CD. Table 2 rejects the null hypothesis of no CD in all the series using all the test statistics. This implies the existence of unobserved common shocks in error across all the cross sections due to the integration of economies in SSA. The result also suggests that policies or events in one country spread quickly to other countries in the region. Apart from the CD test, this study investigates the slope homogeneity among the panel. The result reported in Table 3 reveals that the slope and coefficients of the model vary across countries since the null hypothesis of slope homogeneity among the panel is discarded.

Having confirmed the presence of CD in the study through CD tests, traditional stationarity tests become inept. Thus, this study applies the CIPS and CADF to assess the stationarity properties of the series. The stationarity results in Table 4 reveal that the series does not unit root at the first difference, using intercepts and intercept and trends. Hence, the variables are stationary, and the long-run inference can be made.

Furthermore, the long-run relationship between the variables is validated using the Westerlund panel cointegration test, which is corrected for CD. The test outcome in Table 5 establishes the presence of long-run cointegration among the series. Three of the four test statistics are significant, thus rejecting the null hypothesis of no cointegration between the variables. Further,

cointegration among the series suggests that at least one of the variables has a causal relationship (Usman and Hammar, 2021). In addition, the error correction term using the formula in equation 14 is -0.546. As a result, the short-run disequilibrium is adjusted after an initial shock caused by the divergence of the long-run path from its steady state, and the model returns to equilibrium by 54.6% annually.

4.2. Long-run regression estimates

Having established the existence of CD and cointegration among the series, this section explores the long-run relationship using AMG and CCEMG. The outcomes of the estimate are presented in Table 6. Models 1 and 3 show the direct effect, while models 2 and 4 account for the indirect impact of REM and FD on the environment in SSA using AMG and CCEMG, respectively. Concerning the effect of REM on EFP, all models' results indicate that REM positively affects EFP in Africa. Specifically, a 1% increase in REM worsens the environment by 0.4% in models 1 and 2, 0.8% in model 3, and 0.13% in model 4. This result indicates that REM (diaspora income) significantly adds to the region's environmental degradation. Thus, hypothesis one (H1) of this study is accepted since REM greatly influences EFP. The reasons for this result are not surprising. REM in SSA countries increases disposable income and boosts consumption levels in the domestic economy. An increase in consumption level stimulates aggregate demand and output, thus, the need for more energy.

Further, REM could also enhance industrial production with increased energy use (primarily through fossil fuel), which worsens long-term environmental sustainability. This result supports the empirical findings of

Ahmad et al. (2019), Kibria (2022), and Khan et al. (2020), who found that REM worsens the environment. However, studies conducted by Sharma, Bhattarai, and Ahmed (2019), Arogundade, Hassan, and Bila (2022), and Zafar et al. (2021) find the beneficial role of REM in improving environmental quality.

The relationship between FD and environment proxies by EFP in SSA is statistically positive across the models. This suggests that a 1% increase in FD will spur EFP approximately by 0.5%. Specifically, this result reveals that the current state of FD contributes to sub-Saharan Africa's environmental degradation. Further, the results indicate that FD in SSA is still at its lowest ebb in channeling financial services towards green energy, agriculture, and research and development. Further, the result indicates that financial services rendered by the financial sector increase the buying power of households and firms and are used in buying luxury and non-environmentally friendly products, which puts pressure on the environment. Thus, hypothesis two (H2) is supported since FD significantly influences SSA's environmental quality. Our output is in tandem with the empirics of Baloch et al. (2019), Shahbaz et al. (2016), Bekhet et al. (2017), Philip et al. (2022), Dada et al. (2022b) and Dada et al. (2024d). Nevertheless, the Usman and Hammar (2021) study finds that FD helps curtail environmental degradation.

However, the coefficient of the interactive term of REM and FD is statistically significant and negative. The negative sign of the coefficient hints that FD and REM can act as substitutes that impact the environment. The net effect is calculated using the formula described in Equation 3 to account for the moderating role of FD. The coefficients of the net effect are -0.014 and -0.004 in the

AMG and CCEMG models. The result from the net effect suggests that FD diminishes the positive influence of REM on EFP in Africa. This result indicates that when REM passes through the formal channel, it helps develop the financial sector; thus, the recipients can access various financial services, allowing them to consume environmentally friendly products.

Furthermore, REM funds through the financial sector could be invested in research and development of cleaner, renewable, and efficient energies, boosting environmental quality (Dada, Ojeyinka, and Al-Faryan, 2023). The interactive term's outcome supported the study's third hypothesis (H3). The negative coefficient of the interactive coefficient of FD and REM is reinforced by the empirics of Aljadani et al. (2023), Arogundade et al. (2022), and Yang et al. (2021).

Moreover, urbanization has a reducing impact on EFP. Particularly, urbanization has a statistically significant negative impact on EFP. Thus, if urbanization increases by 1%, environmental degradation will decrease by 0.3% and 0.8% using AMG and CCEMG estimation techniques. The reducing effect of urbanization indicates that urban inhabitants have access to environmental information. Apart from this, the income of urban inhabitants is more than that of rural areas; hence, urban dwellers can easily afford green energy and environmentally friendly equipment. As noted by Charfeddine and Mrabet (2017) and Dada et al. (2024b), the urban populace has access to proper waste disposal and health facilities, potable water, etc., which have long-run sustainability on the ecosystem. This empirical result coincides with the empirics of Dada et al. (2024e), Arogundade et al. (2022), and Danish et al. (2019).

Economic growth has a significant positive effect on EFP. Accordingly, a 1% rise in economic growth implies a 0.01% and 0.03% increase in EFP in SSA. These suggest that an increase in economic growth has negative environmental consequences. The demand for more energy is usually associated with economic growth, affecting the sustainability of the environment in the long run. Further, as the economy grows from one stage to another, exhaustion of natural resources sets in, therefore detrimental to the environment if not used sustainably. This output is in tandem with the published literature by Zafar et al. (2019), Arnaut and Dada (2023), and Dada et al. (2025) and in difference from Danish et al. (2019). FDI has a different effect on EFP in SSA. The result from AMG regression shows that FDI contributes to EFP; however, a decreasing impact of FDI on EFP is established in the CCEMG model. The results show that FDI plays different roles in SSA.

4.3. Result of D-H Granger Causality

The pairwise D-H panel causality test is presented in Table 7. The D-H result in Table 7 is founded on one thousand iterations. Table 7 reveals a one-way causal relationship from REM to EFP, FD to EFP, REM to FD, REM to URB, FDI to REM, URB to GDP, and FDI to GDP. Furthermore, a two-way causal relationship exists between URB and EFP, FDI and EFP, GDP and EFP, URB and FD, and FDI and FD. However, no causal relationship exists between GDP, REM, URB, and FDI in SSA. On one side, the one-way causal relations suggest that policymakers should target the predictive variable to have the desired outcome. For example, REM and sound financial sector development could be used to address the issue of environmental degradation.

However, the two-way causal relation suggests a feedback effect; that is, any policy that affects one of the variables will affect the other variable, and vice-versa. For instance, the two-way relationship between urbanization and EFP implies that policy targeting urbanization will influence the environment; likewise, policies that target the environment will have a consequential effect on the urban centers. The precis of the D-H causality test is shown in Figure 2. The bidirectional relationship between economic growth and EFP is supported by the works of Dada et al. (2022a), Ahmad et al. (2020), Usman et al. (2020), and Danish et al. (2019).

4.4. Robustness Check- Endogeneity Issue

The study accounted for the issue of endogeneity as part of the sensitivity analysis of the long-run estimates of the AMG and CCEMG. The study addresses this problem-endogeneity in the remittances-financial development-environment nexus using the Two-Step System Generalised Method of Moment (2SGMM). The 2SGMM is more efficient and reliable when the number of cross-sections (N) is more than the time dimension (T) (Arellano and Bover, 1995; Dada, 2021). To fulfil this condition, a two-year average of the data set is used, i.e. 1991-1992, 1993-1994, 1995-1996, and 2021-2022. This yields a total time series of sixteen (T=16). This approach (averaging the data) is beneficial to this present study as it reduces the problem of producing too many instruments and also smoothing the influence of business cycles inherent in macro data, which can bias the result of the 2SGMM (Law et al., 2018; Olaniyi and Oladeji, 2021; Dada et al., 2022d).

The result of the 2SGMM is presented in Table 8. The result in Table 8 shows that the instruments used were valid through the non-significance of the probability of Hansen J-statistic. Furthermore, the result reveals the absence of second-order autocorrelation-AR(2) in the model due to its non-significant probability value. These diagnostic tests imply that the model is free from serial correlation in the differentiated residual and over-identification restriction.

The result of the 2SGMM in Table 8 aligns with the long-run results of the AMG and CCEMG. Specifically, the result shows that remittances and financial development contribute to the region's ecological footprint growth. Similarly, the coefficient of the interactive term of financial development and remittance is significantly negative, suggesting that they lessen the ecological footprint and strengthen the ecological asset. Furthermore, the effect of other control variables also aligns with the conclusion of the AMG and CCEMG, except for the slightly different coefficient size and significance level.

5. Conclusion

This novel study examines REM's direct and indirect effects on environmental sustainability through FD in twenty-seven countries between 1991 and 2022. To do so, environmental deterioration is measured using the EFP, a more comprehensive series (based on six separate environmental indicators). CD and slope heterogeneity are addressed using second-generation estimate approaches. The CD and slope homogeneity test results show that CD exists among the units and slope heterogeneity between countries. Furthermore, the CIPS and CADF stationarity tests reveal that the series does not have unit roots in their process. Westerlund's (2007)

panel cointegration also establishes a long-run relationship among the series, suggesting a causal relationship.

The outputs from the AMG and CCEMG estimators show that REM, FD, and economic growth have a positive and significant influence on EFP in SSA. This suggests that these variables worsen the long-run environmental sustainability of the region. However, urbanization has a significant negative impact on EFP, thus reducing environmental degradation. FDI positively affects EFP in the AMG model but turns negative when using the CCEMG technique. An interactive term of FD and REM was included in the model to provide information for the indirect effect in the nexus. The result of the interactive term has a negative and significant impact on EFP in SSA. This implies that FD and REM perform substitutability roles in influencing environmental sustainability. The net effect reveals that FD moderates the linkages between REM and the environment. The Dumitrescu and Hurlin (2012) causality test indicates a one-way relation between REM to EFP, FD to EFP, and REM to FD.

The upshot of this study offers some vital policy prescriptions to governments, policymakers, and regulatory authorities in SSA. The outcome of this study implies that REM reduces the ecological asset. Hence, remittances should be channeled to a sustainable environment through the financial development. The inflow of REM through the official channel (financial sector) will make a pool of funds available, which could be used for green finance. With the available pool of funds, the financial sector could move from traditional finance to sustainable finance, where significant financial resources are tailored toward environmentally friendly

production through research and development, green energy, and eco-friendly technology.

Furthermore, REM could be used as an alternative source of funds and leverage to develop the financial sector. Financial credit should be offered to households and firms that want to embark on a green environment at a subsidized or low interest rate. Similarly, activities of the financial sector should be checked to reduce, if not eradicate, the loopholes and lapses that do not allow channeling resources to green finances.

Since economic growth hurts the ecosystem, officials in SSA need to align their growth policy with achieving a sustainable green environment. Specifically, greener growth should be the focus in the area. Economies in SSA should employ clean, natural, and renewable energy sources (e.g., solar, natural gas, biogas, wind, hydro, and geothermal), which can reduce environmental pollution without hindering the economic growth prospects in SSA countries. Lastly, ecological education and awareness should be promoted in the region to educate the citizenry about the adverse effects of environmental degradation on the ecosystem.

It is essential to keep in mind that despite the importance of this study for policymaking, it still has some limitations that can be addressed by future research. The study is limited to SSA, while aggregate EFP assesses environmental sustainability. Future studies should consider the six EFP indicators and the role of institutional quality in such nexus.

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Appendix 1

Benin, Botswana, Burkina Faso, Cameroon, Eswatini, Congo Republic, Cote d'Ivoire, Gabon, Lesotho, Ghana, Guinea, Guinea Bissau, Kenya, Madagascar, Malawi, Mali, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Togo, Tanzania, and Zimbabwe

Appendix 2

Table 1. Descriptive Statistics and Correlation Matrix

	EFP	REM	FD	URB	FDI	GDP
Mean	1.440	4.013	0.146	36.799	2.999	1900.602
Median	1.233	1.075	0.113	35.114	1.730	847.150
Maximum	3.818	145.149	0.627	88.976	50.018	11937.64
Minimum	0.653	0.000	0.000	5.491	-8.589	126.954
Std. Dev.	0.662	13.101	0.102	15.847	5.146	2503.151
Skewness	1.681	7.539	1.955	0.811	4.122	2.115
Kurtosis	5.207	67.211	7.618	3.740	26.392	6.623
EFP	1	-0.069	0.470	0.451	-0.071	0.426
REM		1	-0.116	-0.121	0.179	-0.165
FD			1	0.291	-0.064	0.503
URB				1	0.046	0.322
FDI					1	-0.068
GDP						1

Source: Authors' computation

EFP is ecological footprint, REM is remittances, FD is financial development, URB is urbanization, FDI is foreign direct investment, and GDP is gross domestic product.

Table 2. Cross-Sectional Dependence Tests

Variables	BP-LM Stats.	PS- LM Stats.	BCS-LM Stats.	P-CD Stats.
EFP	1738.317***	52.360***	51.841***	4.610***
REM	2544.551***	82.790***	82.271***	8.786***
FD	3402.371***	115.166***	114.647***	50.924***
URB	7903.005***	285.032***	284.512***	73.476***
FDI	1200.752***	32.071***	31.553***	18.279***
GDP	5225.670***	183.982***	183.463***	46.309***

*** represent 1% significance level

Source: Authors' computation

Table 3. Slope homogeneity

T-statistics	Delta	p-Value
Δ	1.767*	0.077
Δ_{adj}	1.958*	0.050

* represent 10% significance level

Source: Authors' computation

Table 4. Unit Root Test

Series	CADF		CIPS	
	Level	First Diff.	Level	First Diff.
Intercept				
EFP	-1.203	-4.829***	-1.587	-6.150***
REM	-1.886	-5.307***	-1.448	-6.143***
FD	-2.038	-5.077***	-1.229	-5.899***
URB	-1.837	-4.489***	-1.563	-6.169***
FDI	-1.494	-5.265***	-1.219	-6.118***
GDP	-1.602	-4.948***	-1.409	-6.190***
Intercept and Trend				
EFP	-1.482	-4.580***	-1.900*	-6.346***
REM	-1.532	-5.271***	-1.766*	-6.242***
FD	-1.149	-5.066***	-1.200	-6.026***
URB	-1.433	-4.404***	-1.972*	-6.352***
FDI	-1.640	-5.194***	-1.388	-6.305***
GDP	-1.536	-4.815***	-1.620	-6.420***

***, * represent 1%, and 10% significance levels

Source: Authors' computation

Table 5. Westerlund Cointegration Test

Statistic	Value	Z-value	p-value
Gt	-2.631**	-2.195	0.014
Ga	-11.985	-0.752	0.226
Pt	-14.335***	-4.121	0.000
Pa	-15.283***	-6.199	0.000

***, ** represent 1%, and 5% significance levels

Source: Authors' computation

Table 6. Result of Regression Analysis

Dependent variable: EFP

Series	AMG				CCEMG			
	Model 1		Model 2		Model 3		Model 4	
	Coefficient	Z value	Coefficient	Z value	Coefficient	Z value	Coefficient	Z value
REM	0.004***	3.98	0.004***	2.98	0.008***	5.37	0.013**	2.58
FD	0.005***	8.14	0.005***	8.80	0.004***	7.20	0.005***	8.44
REM*FD			-0.126**	-2.10			-0.112***	-3.10
URB	-0.003***	-4.78	-0.003***	-4.13	-0.007***	-8.07	-0.008***	-7.66
FDI	0.006*	1.77	0.005	1.55	-0.006	-0.99	-0.012*	-1.92
GDP	0.0001***	9.41	0.0001***	8.99	0.0003***	21.90	0.0003***	21.09
Net Effect			-0.014				-0.004	

***, **, * represent 1%, 5% and 10% respectively

Source: Authors' computation

Table 7. D-H Causality Tests

Hypothesis	W-stat	Z bar-stat	Prob	Inference	Conclusion
REM $\Rightarrow$ EFP	6.015**	6.483	0.023	Reject	Unidirectional causality from REM to EFP
EFP $\Rightarrow$ REM	0.927	-0.267	0.962	Accept	
FD $\Rightarrow$ EFP	5.801**	5.943	0.015	Reject	Unidirectional causality from FD to EFP
EFP $\Rightarrow$ FD	3.134	2.946	0.277	Accept	
URB $\Rightarrow$ EFP	5.580*	9.3016	0.099	Reject	Bidirectional causality between URB and EFP
EFP $\Rightarrow$ URB	3.962*	5.099	0.055	Reject	
FDI $\Rightarrow$ EFP	7.977*	7.318	0.000	Reject	Bidirectional causality between FDI and EFP
EFP $\Rightarrow$ FDI	3.522*	3.955	0.065	Reject	
GDP $\Rightarrow$ EFP	3.739*	4.517	0.075	Reject	Bidirectional causality between GDP and EFP
EFP $\Rightarrow$ GDP	4.063**	5.359	0.026	Reject	
FD $\Rightarrow$ REM	2.437	1.137	0.764	Accept	Unidirectional causality from REM to FD
REM $\Rightarrow$ FD	4.188*	5.6867	0.0710	Reject	
URB $\Rightarrow$ REM	3.824	4.738	0.684	Accept	Unidirectional causality from REM to URB
REM $\Rightarrow$ URB	4.861*	6.966	0.086	Reject	
FDI $\Rightarrow$ REM	4.165**	5.621	0.049	Reject	Unidirectional causality from FDI to REM
REM $\Rightarrow$ FDI	2.893	2.320	0.373	Accept	
GDP $\Rightarrow$ REM	4.208	5.736	0.106	Accept	No causal relationship
REM $\Rightarrow$ GDP	2.412	1.072	0.754	Accept	

Hypothesis	W-stat	Z bar-stat	Prob	Inference	Conclusion
URB $\nRightarrow$ FD	7.990***	15.562	0.010	Reject	Bidirectional causality between URB and FD
FD $\Rightarrow$ URB	4.689***	6.986	0.038	Reject	
FDI $\nRightarrow$ FD	3.873*	4.867	0.084	Reject	Bidirectional causality between FDI and FD
FD $\Rightarrow$ FDI	4.162**	4.019	0.024	Reject	
GDP $\nRightarrow$ FD	6.153***	10.789	0.003	Reject	Bidirectional causality between GDP and FD
FD $\Rightarrow$ GDP	5.211***	8.344	0.003	Reject	
FDI $\nRightarrow$ URB	3.644	4.271	0.116	Accept	No causal relationship
URB $\nRightarrow$ FDI	4.485	6.457	0.102	Accept	
GDP $\nRightarrow$ URB	3.658	4.309	0.359	Accept	Unidirectional causality from URB to GDP
URB $\nRightarrow$ GDP	7.567**	14.465	0.017	Reject	
GDP $\nRightarrow$ FDI	3.414	3.673	0.216	Accept	Unidirectional causality from FDI to GDP
FDI $\nRightarrow$ GDP	3.823**	4.738	0.034	Reject	

***, **, * represent 1%, 5% and 10% respectively

$\nRightarrow$ mean “does not Granger-cause”

Source: Authors' computation

Table 8. Robustness Check- two-step system generalized method of moment (2SGMM)
Dependent variable: EFP

Series	2SGMM			
	Model 1		Model 2	
	Coefficient	t- Stat.	Coefficient	t- Stat.
EFP(-1)	0.243***	4.413	0.587***	7.195
REM	0.003**	2.231	0.001*	2.052
FD	0.012**	2.581	0.003**	2.671
REM*FD			-0.011***	-4.182
URB	-0.009**	-2.659	-0.005***	-6.426
FDI	0.003	1.347	0.005	1.497
GDP	0.0001**	2.506	0.0001**	2.874
Net Effect			-0.001	
AR(1) (prob)	0.000		0.000	
AR(2) (prob)	0.809		0.942	
J-statistic (prob)	0.576			

***, **, * represent 1%, 5% and 10% respectively

Source: Authors' computation

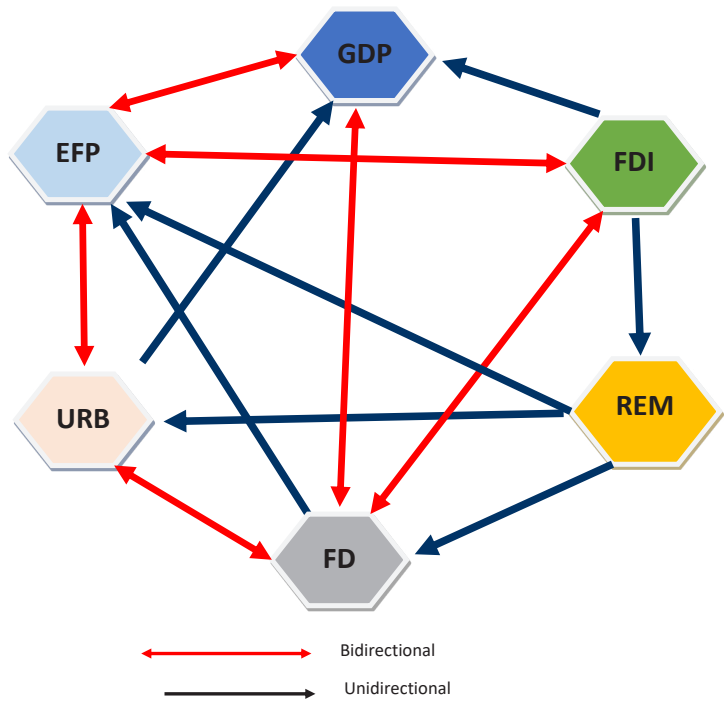


Figure 2. Direction of Causality
Source: Authors' concept